US009290139B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.: US 9,290,139 B2**
(45) **Date of Patent: Mar. 22, 2016**

(54) **CRASH BOX FOR VEHICLE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/526,022**

(22) Filed: **Oct. 28, 2014**

(65) **Prior Publication Data**

US 2015/0343972 A1 Dec. 3, 2015

(30) **Foreign Application Priority Data**

Jun. 3, 2014 (KR) 10-2014-0067946

(51) **Int. Cl.**
B60R 19/34 (2006.01)
B60R 19/02 (2006.01)
B60R 19/30 (2006.01)

(52) **U.S. Cl.**
CPC ***B60R 19/34*** (2013.01); ***B60R 19/023*** (2013.01); ***B60R 19/30*** (2013.01)

(58) **Field of Classification Search**
CPC B61D 7/00; H04N 9/077; A01B 13/08; A01B 63/166; A01C 17/00; B01D 35/027; B29C 45/1704; H01L 21/67326; H01L 21/67383; H01L 2924/0002
USPC 293/133
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,413,856	A *	11/1983	McMahan	B60R 19/26 293/110
6,227,582	B1 *	5/2001	Ichien	B60R 19/18 293/132
6,705,653	B2	3/2004	Gotanda et al.	
6,808,215	B2 *	10/2004	Sakuma	B60R 19/34 293/102
7,017,960	B2 *	3/2006	Reierson	B60R 19/18 293/102
7,252,314	B2 *	8/2007	Tamura	F16F 7/123 293/133
7,533,913	B2 *	5/2009	Bae	B60R 19/34 293/132
7,871,122	B2 *	1/2011	Salomonsson	B60R 19/34 296/187.03
7,926,868	B2 *	4/2011	Braunbeck	F16F 7/123 293/132
8,210,601	B2 *	7/2012	Terada	B60R 19/34 293/133

(Continued)

FOREIGN PATENT DOCUMENTS

JP	2005-162061 A	6/2005
JP	2006-347262 A	12/2006

(Continued)

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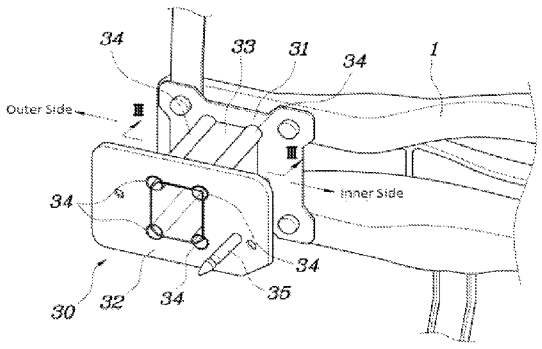
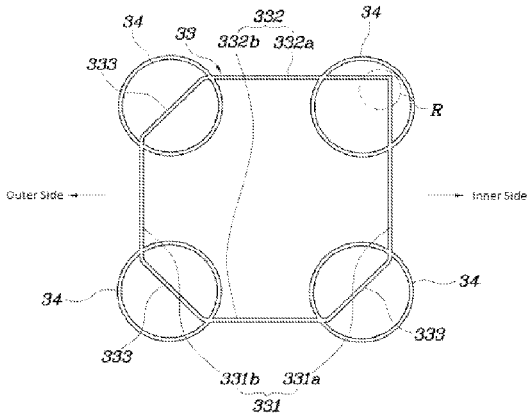
(57) **ABSTRACT**

A crash box for a vehicle may include a front connection portion that is connected to both ends of a back beam of the vehicle, a rear connection portion that is connected to a side member of the vehicle, an intermediate connection portion for connecting the front connection portion and the rear connection portion, which is formed as a hollow box shape and through which a cut cross-section of a heptangular shape is formed in a vehicle width direction, and a plurality of reinforcement ribs formed at an inner space of the intermediate connection portion.

7 Claims, 7 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

8,919,834	B2 *	12/2014	Freundl	B60R 19/18 293/133
2002/0063433	A1 *	5/2002	Gotanda	B60R 19/34 293/132
2005/0062300	A1 *	3/2005	Toneatti	B60R 19/34 293/133
2008/0106107	A1 *	5/2008	Tan	B60R 19/34 293/133
2009/0085362	A1 *	4/2009	Terada	B60R 19/34 293/132
2010/0164238	A1 *	7/2010	Nakanishi	F16F 7/12 293/132
2011/0291431	A1 *	12/2011	Buschsieweke	B60R 19/34 293/133
2013/0048455	A1 *	2/2013	Friedrich	B60R 19/34 188/377
2014/0292007	A1 *	10/2014	Kawamata	B60R 19/34 293/133
2015/0232050	A1 *	8/2015	Yamada	B60R 19/34 296/187.1

FOREIGN PATENT DOCUMENTS

JP	2009-202630	A	9/2009
JP	2009-280145	A	12/2009
KR	10-2011-0072901	A	6/2011
KR	10-2012-0010382	A	2/2012
KR	10-1154262	B1	6/2012

* cited by examiner

FIG. 1 (Related Art)

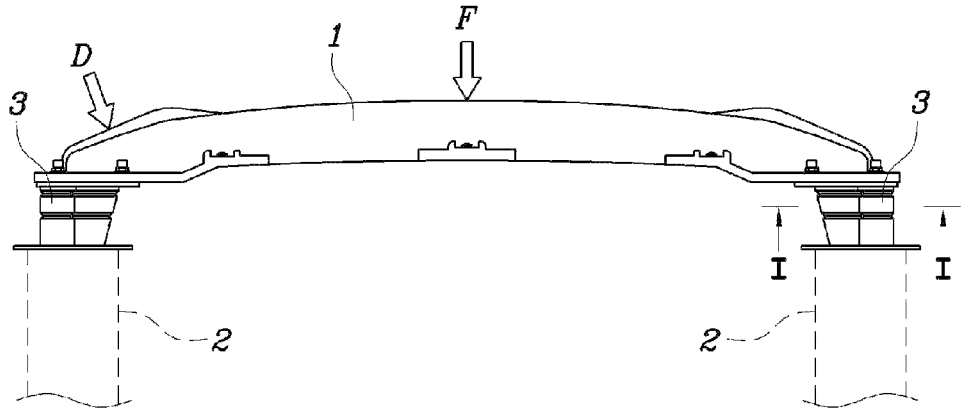


FIG. 2 (Related Art)

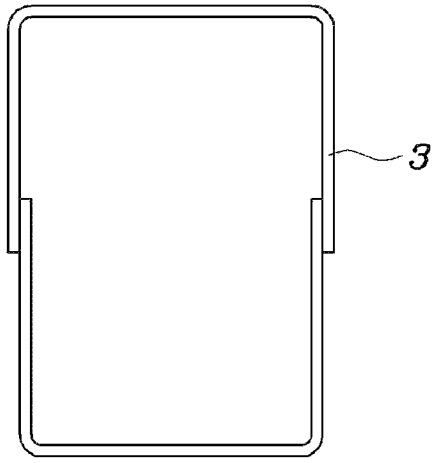


FIG. 3 (Related Art)

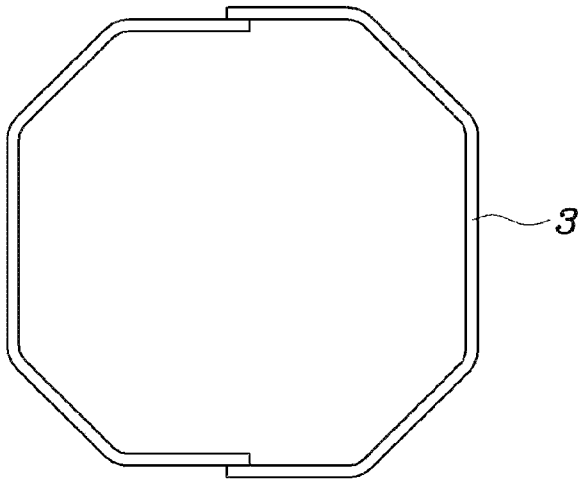


FIG. 4

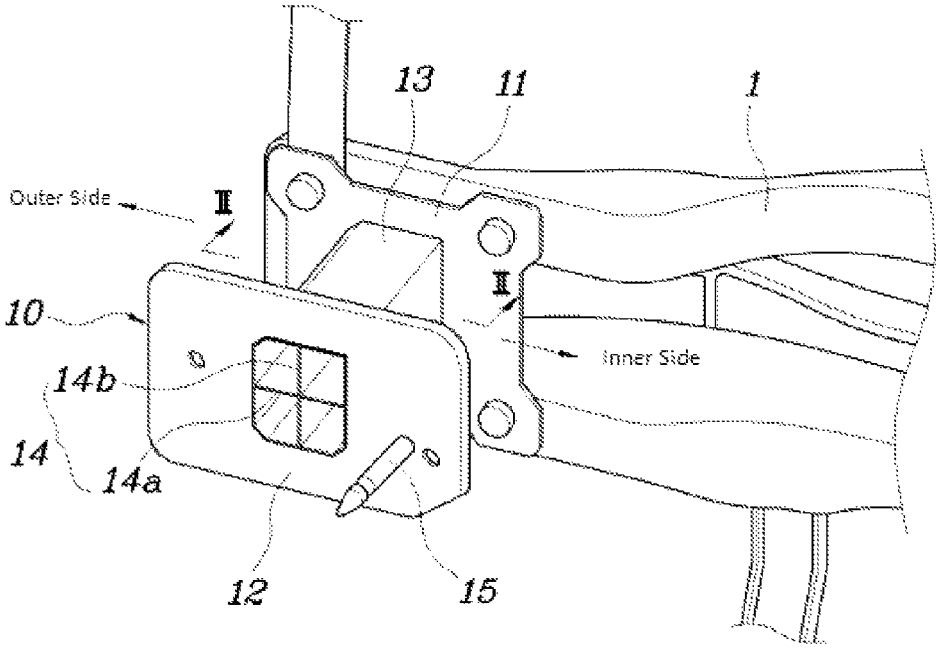


FIG. 5

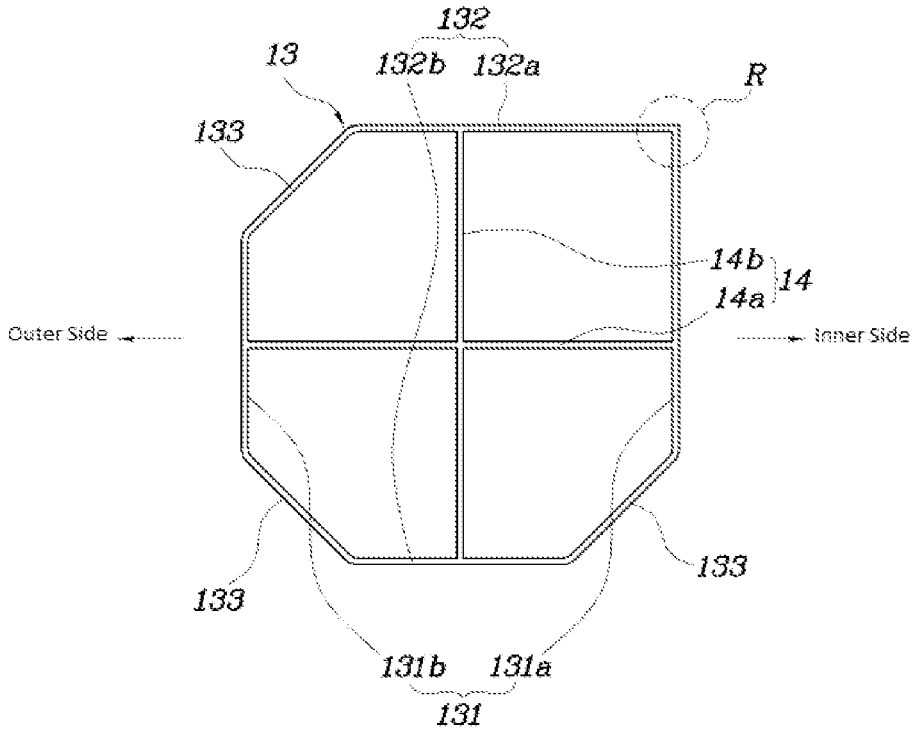

132
13
132b
132a
R
133
14b
14
14a
Outer Side
Inner Side
133
133
131b
131a
131

FIG. 6

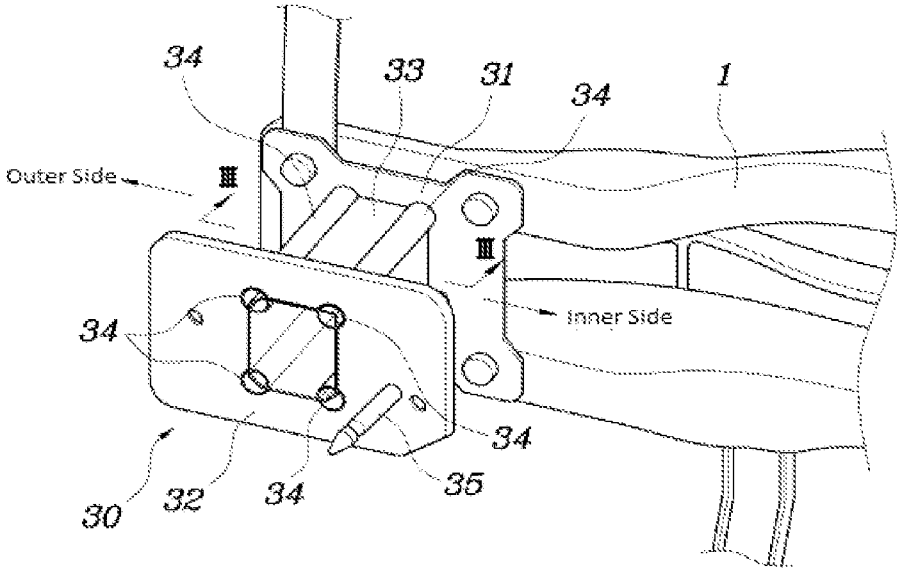

34
33
31
34
1
Outer Side
III
III
Inner Side
34
34
30
32
34
35

FIG. 7

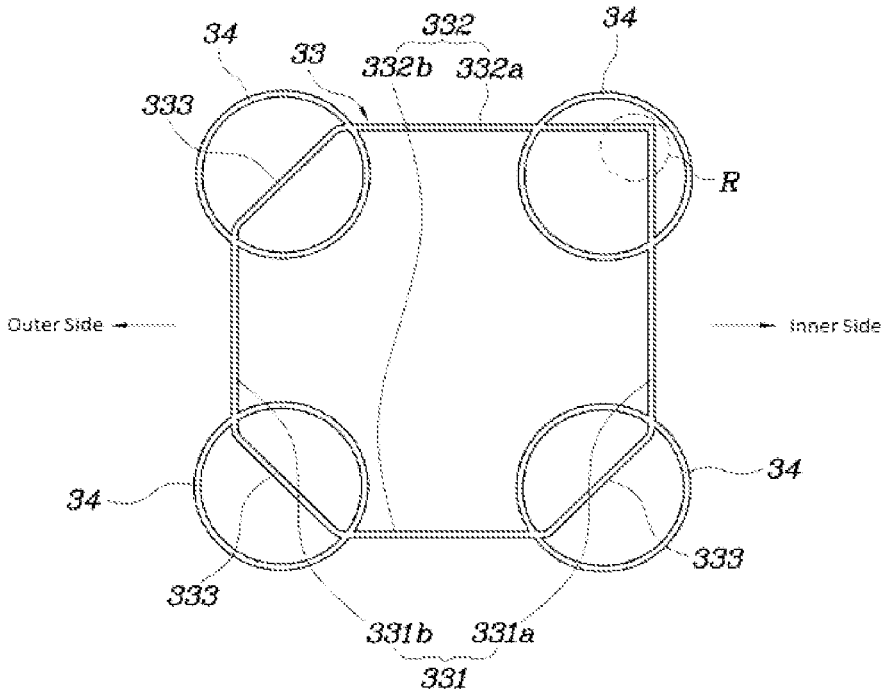

34
33
332
332b
332a
34
333
R
Outer Side
Inner Side
34
34
333
333
331b
331a
331

FIG. 8

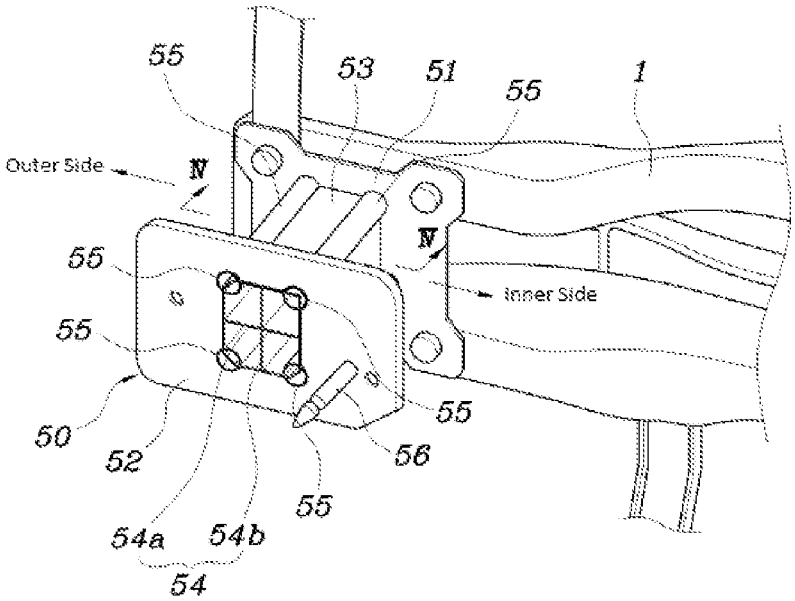

55
53
51
55
1
Outer Side
N
N
55
Inner Side
55
55
50
52
56
55
54a
54b
54

FIG. 9

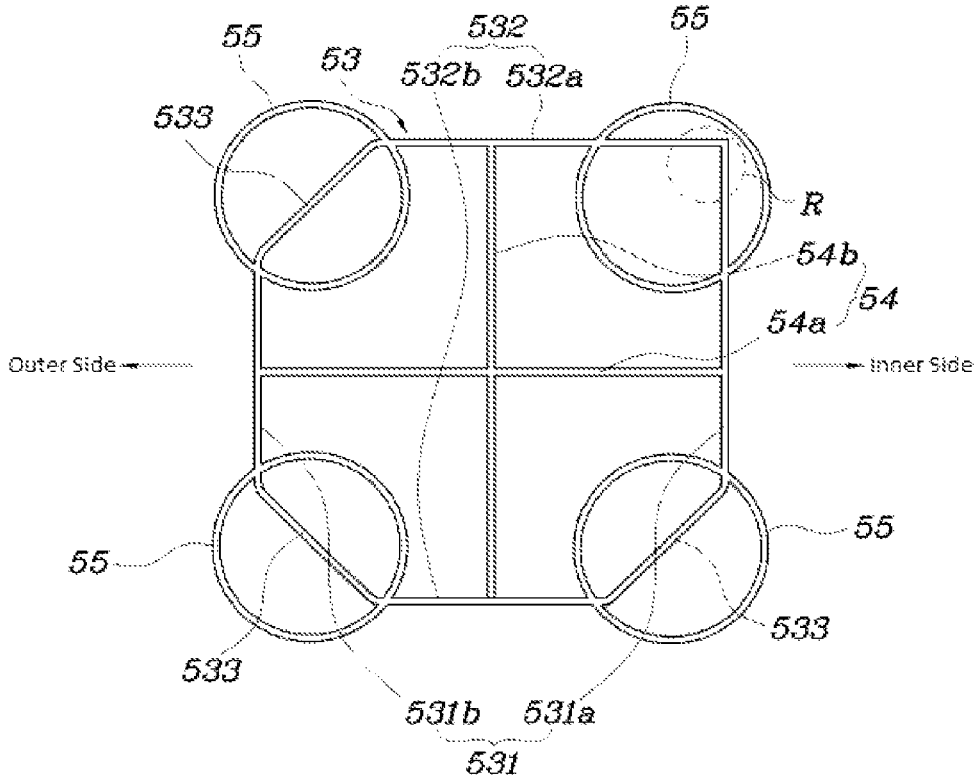

55
53
532
532b
532a
55
533
R
54b
54
54a
Outer Side
Inner Side
55
55
533
533
531b
531a
531

FIG. 10A

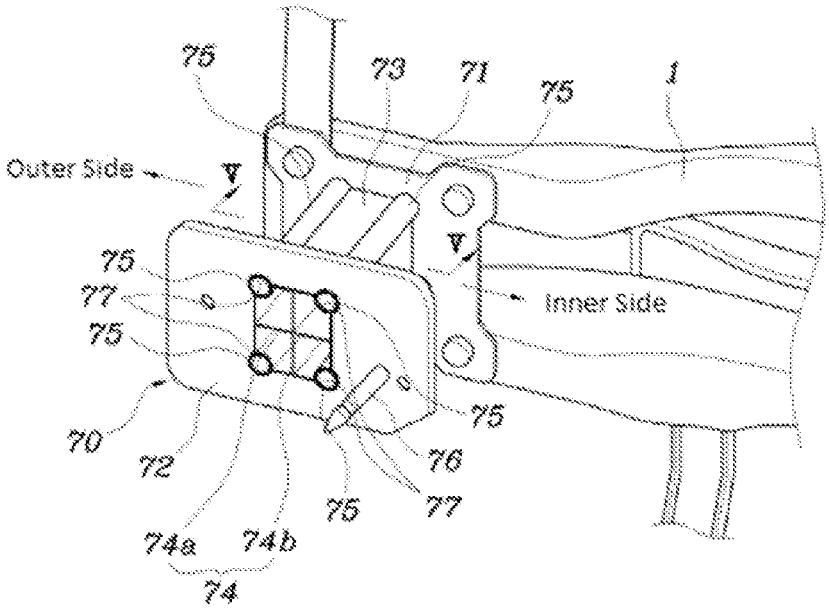


FIG. 10B

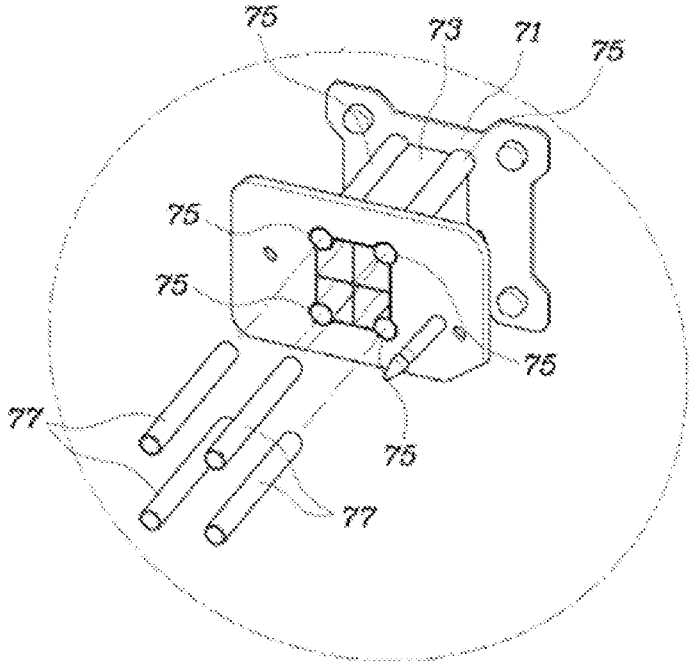
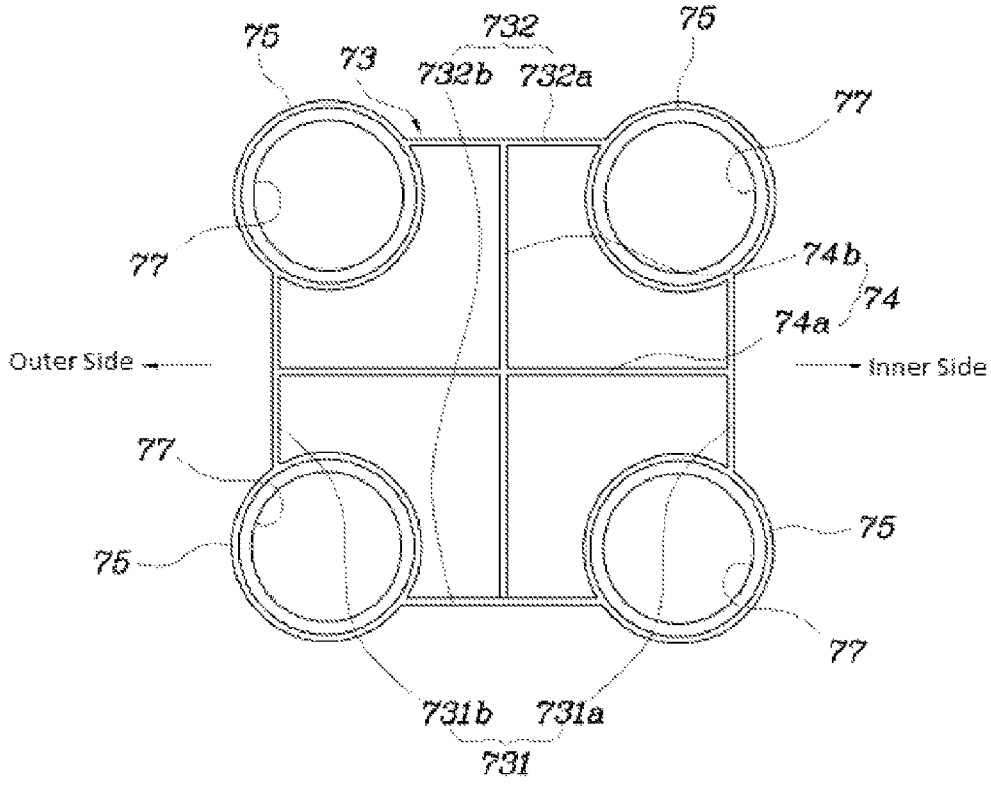


FIG. 11


75
73
732
732b
732a
75
77
77
74b
74
74a
Outer Side
Inner Side
77
75
75
77
731b
731a
731

CRASH BOX FOR VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority to Korean Patent Application Number 10-2014-0067946 filed Jun. 3, 2014, the entire contents of which is incorporated herein for all purposes by this reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a crash box for a vehicle, and more particularly, to a crash box for a vehicle which is installed between a side member and a back beam of a bumper which is positioned on a vehicle body to absorb impact energy when a collision occurs.

2. Description of Related Art

Generally, a bumper of a vehicle is installed at a front side and a rear side of the vehicle to protect a vehicle body and a passenger when a front or rear collision occurs and further protects a hood, and an engine and various devices installed in an engine room and the like.

The bumper is provided with a bumper cover that forms an outer shape of the bumper, an energy absorber that dampens impact when a collision occurs and has a shape recovery function after the collision, and a back beam (referred to as "bumper beam") that supports the energy absorber and is installed on the side member wherein a crash box **3** for absorbing impact energy when a collision occurs is installed between the back beam **1** and the side member **2**.

The crash box **3** is configured to absorb impact energy by being compress-deformed in an axial direction (front/rearward) in a case where the impact energy is applied to the bumper and the crash box may be configured to minimize the deformation of the side member so as to minimize a repair cost.

Further, the crash box needs to be configured to satisfy the regulation of the Research Council for Automobile Repairs (RCAR), which is referred to as a representative regulation of the automobile industrial field.

Referring to FIG. **1**, in the related art, there existed only a corner test way that evaluates compress-deformation performance by applying an impact D of a diagonal direction to the back beam **1** of a vehicle in a conventional RCAR performance test. However, recently a center test way has been added, which evaluates a load support performance by applying an impact F of an axial direction of a vehicle to a middle portion of the back beam **1**.

Meanwhile, a conventional crash box **3** is formed to have cross-section of a circular shape or a quadrangular shape as shown in FIG. **2**, or an octagonal shape as shown in FIG. **3**, wherein when it is formed to have cross-section of an octagonal shape which has a high sectional coefficient, an RCAR corner test obtains a high performance satisfaction degree.

However, when the crash box **3** is formed to have cross-section of an octagonal shape, it is advantageous for a compress-deformation, but it is disadvantageous in supporting the load, and thus it does not efficiently respond to an RCAR center test. Further, when the crash box **3** is formed to have cross-section of a quadrangular shape, it is advantageous in supporting the load and thus it efficiently responds to an RCAR center test but it is disadvantageous for the compress-deformation and thus it does not efficiently respond to the RCAR corner test.

Accordingly, there needs to be developed a crash box having an optimum shape which is advantageous in responding to both the RCAR corner test and RCAR center test.

The information disclosed in this Background of the Invention section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

BRIEF SUMMARY

Various aspects of the present invention are directed to providing a crash box for a vehicle, which can satisfy simultaneously RCAR corner test and center test through optimizing a sectional shape and further aim to lighten the weight.

According to various aspects of the present invention, a crash box for a vehicle may include a front connection portion that is connected to both ends of a back beam of the vehicle, a rear connection portion that is connected to a side member of the vehicle, an intermediate connection portion for connecting the front connection portion and the rear connection portion, which is formed as a hollow box shape and through which a cut cross-section of a heptangular shape is formed in a vehicle width direction, and a plurality of reinforcement ribs formed at an inner space of the intermediate connection portion.

The intermediate connection portion may have a cross-section of a heptangular shape which is formed by connecting a pair of vertical sides formed in parallel, a pair of horizontal sides formed in parallel, and three inclined sides that each connect slantly each vertical and the horizontal side, the pair of vertical sides may include an inner side arranged in an inner side direction of the vehicle and an outer side arranged in an outer side direction of the vehicle, the pair of horizontal sides may include an upper side arranged in an upper side direction of the vehicle and a lower side arranged in a lower side direction of a vehicle; and the reinforcement rib may include a horizontal rib for connecting the inner side and the outer side and a vertical rib for connecting the upper side and the lower side.

Both ends of the horizontal rib may connect the inner side and the outer side at an intermediate location between the upper side and the lower side, both ends of the vertical rib may connect the upper side and the lower side at an intermediate location between the inner side and the outer side, and the horizontal rib and the vertical rib may be connected in a cross shape.

The horizontal rib and the vertical rib may be connected entirely along a front/rear length direction of the intermediate connection portion.

The inner side and the upper side may be connected at an angle of 90 degrees to form a reinforcement portion and the reinforcement portion may be arranged in an inner side direction of the vehicle.

The crash box may be formed of plastic.

A guide pin may be connected to the rear connection portion, which guides an assembly location when assembled with the side member.

A crash box for a vehicle according to various embodiment of the present invention may include a front connection portion connected to both ends of a back beam of the vehicle; a rear connection portion connected to a side member of the vehicle, an intermediate connection portion for connecting the front connection portion and the rear connection portion, formed as a hollow box shape and through which a cross-section of a heptangular shape is formed in a vehicle width

direction, and a plurality of pipe tubes formed along a front/rear length direction of the intermediate connection portion.

The intermediate connection portion may have the cross-section of the heptangular shape which is formed by connecting a pair of vertical sides formed in parallel, a pair of horizontal sides formed in parallel, and three inclined sides that connect slantly the vertical sides and the horizontal sides, the pair of vertical sides may include an inner side arranged in an inner side direction of a vehicle and an outer side arranged in an outer side direction of a vehicle, the pair of horizontal sides may include an upper side arranged in an upper side direction of the vehicle and a lower side arranged in a lower side direction of the vehicle, the inner side and the upper side are connected at an angle of 90 degrees to form a reinforcement portion, and each pipe tube may be disposed on the reinforcement portion and each of the three inclined sides.

The reinforcement portion may be arranged in an inner side direction of the vehicle.

The crash box may be formed of plastic.

A guide pin may be connected to the rear connection portion, which guides an assembly location when assembled with the side member.

A crash box for a vehicle according to various embodiments of the present invention may include a front connection portion connected to both ends of a back beam of the vehicle, a rear connection portion that is connected to a side member of the vehicle, an intermediate connection portion for connecting the front connection portion and the rear connection portion, which is formed as a hollow box shape and through which a cross-section of a heptangular shape is formed in a vehicle width direction, a plurality of reinforcement ribs formed at an inner space of the intermediate connection portion, and a plurality of pipe tubes formed along a front/rear length direction of the intermediate connection portion.

The intermediate connection portion may have the cross-section of the heptangular shape which is formed by connecting a pair of vertical sides formed in parallel, a pair of horizontal sides formed in parallel and three inclined sides that connect slantly the vertical sides and the horizontal sides, the pair of vertical sides may include an inner side arranged in an inner side direction of a vehicle and an outer side arranged in an outer side direction of the vehicle, the pair of horizontal sides may include an upper side arranged in an upper side direction of the vehicle and a lower side arranged in a lower side direction of the vehicle, the inner side and the upper side are connected at an angle of 90 degrees to form a reinforcement portion, the reinforcement rib may include a horizontal rib for connecting the inner side and the outer side and a vertical rib for connecting the upper side and the lower side, and each pipe tube may be disposed on the reinforcement portion and each of the three inclined sides.

Both ends of the horizontal rib may connect the inner side and the outer side at an intermediate location between the upper side and the lower side, both ends of the vertical rib may connect the upper side and the lower side at an intermediate location between the inner side and the outer side, and the horizontal rib and the vertical rib may be connected in a cross shape.

The horizontal rib and the vertical rib may be connected entirely along a front/rear length direction of the intermediate connection portion.

The reinforcement portion may be arranged in an inner side direction of the vehicle.

The crash box may be formed of plastic.

A guide pin may be connected to the rear connection portion, which guides an assembly location when assembled with the side member.

A crash box for a vehicle according to various embodiments of the present invention may include a front connection portion connected to both ends of a back beam of the vehicle, a rear connection portion that is connected to a side member of the vehicle, a plurality of pipe tubes which connect the front connection portion and the rear connection portion and are arranged on four corners up/downward and left/rightward by a sectional arrangement cut in a vehicle width direction, an intermediate connection portion for connecting the front connection portion, the rear connection portion, and each pipe tube, which is adjacent to the front and rear connection portions and formed as a hollow box shape, and a plurality of reinforcement ribs formed at an inner space of the intermediate connection portion.

The crash box for a vehicle may further include a reinforcement pipe that is arranged to be inserted into each pipe tube.

The intermediate connection portion may include a pair of vertical sides formed in parallel and a pair of horizontal sides formed in parallel, the pair of vertical sides may include an inner side arranged in an inner side direction of the vehicle and connecting upper and lower pipe tubes at an inner side direction of the vehicle and an outer side arranged in an outer side direction of the vehicle and connecting the upper and lower pipe tubes at an outer side of the vehicle, the pair of horizontal sides may include an upper side arranged in an upper side direction of a vehicle and connecting the upper pipe tubes that are arranged at the inner and the outer side directions of the vehicle and a lower side arranged in a lower side direction of the vehicle and connecting the lower pipe tubes arranged at the inner and the outer side directions of the vehicle, and the reinforcement rib may include a horizontal rib for connecting the inner side and the outer side and a vertical rib for connecting the upper side and the lower side.

Both ends of the horizontal rib may connect the inner side and the outer side at an intermediate location between the upper side and the lower side, both ends of the vertical rib may connect the upper side and the lower side at an intermediate location between the inner side and the outer side, and the horizontal rib and the vertical rib may be connected in a cross shape.

The horizontal rib and the vertical rib may be connected entirely along a front/rear length direction of the intermediate connection portion.

The reinforcement pipe may be press-inserted into each pipe tube and the reinforcement pipe may be formed of plastic.

It is understood that the term "vehicle" or "vehicular" or other similar term as used herein is inclusive of motor vehicles in general such as passenger automobiles including sports utility vehicles (SUV), buses, trucks, various commercial vehicles, watercraft including a variety of boats and ships, aircraft, and the like, and includes hybrid vehicles, electric vehicles, plug-in hybrid electric vehicles, hydrogen-powered vehicles and other alternative fuel vehicles (e.g., fuels derived from resources other than petroleum). As referred to herein, a hybrid vehicle is a vehicle that has two or more sources of power, for example both gasoline-powered and electric-powered vehicles.

The methods and apparatuses of the present invention have other features and advantages which will be apparent from or are set forth in more detail in the accompanying drawings, which are incorporated herein, and the following Detailed Description, which together serve to explain certain principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating a crash box installed between a back beam of a bumper and a side member according to the related art.

FIG. **2** is a cross-sectional view taken along line I-I of FIG. **1**, which illustrates a conventional crash box formed to have cross-section of a quadrangular shape according to the related art.

FIG. **3** is a cross-sectional view of another conventional crash box formed to have cross-section of an octagonal shape according to the related art.

FIG. **4** is a perspective view illustrating an exemplary crash box according to the present invention.

FIG. **5** is a cross-sectional view taken along line II-II of FIG. **4**.

FIG. **6** is a perspective view illustrating an exemplary crash box according to the present invention.

FIG. **7** is a cross-sectional view taken along line III-III of FIG. **6**.

FIG. **8** is a perspective view illustrating an exemplary crash box according to the present invention.

FIG. **9** is a cross-sectional view taken along line IV-IV of FIG. **8**.

FIG. **10**A and FIG. **10**B are perspective views illustrating an exemplary crash box according to the present invention.

FIG. **11** is a cross-sectional view taken along line V-V of FIG. **10**.

It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various features illustrative of the basic principles of the invention. The specific design features of the present invention as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particular intended application and use environment.

DETAILED DESCRIPTION

Reference will now be made in detail to various embodiments of the present invention(s), examples of which are illustrated in the accompanying drawings and described below. While the invention(s) will be described in conjunction with exemplary embodiments, it will be understood that the present description is not intended to limit the invention(s) to those exemplary embodiments. On the contrary, the invention(s) is/are intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

A crash box **10** according to various embodiments of the present invention, as shown in FIGS. **4** and **5**, may include a front connection portion **11** that is connected to both ends of a back beam **1**, a rear connection portion **12** that is connected to a side member **2** (referring to FIG. **1**), an intermediate connection portion **13** for connecting the front connection portion **11** and the rear connection portion **12**, which is formed as a hollow box shape and through which a cut cross-section of a heptangular shape is formed in a vehicle width direction, and a plurality of reinforcement ribs **14** formed at an inner space of the intermediate connection portion **13**.

That is, the intermediate connection portion **13** of the crash box **10** according to an embodiment of the present invention is formed to have the cross-section of a heptangular shape and thus it is advantageous for a compress-deformation thereby to implement a high performance satisfaction degree when an RCAR corner test is performed, and further, a sufficient rigidity is maintained through the plurality of reinforcement ribs **14** and thus the intermediate connection portion **13** is advantageous in responding to an RCAR center test.

The intermediate connection portion **13** is configured to have the cross-section of a heptangular shape which is formed by connecting a pair of vertical sides **131** formed in parallel, a pair of horizontal sides **132** formed in parallel, and 3 inclined sides **133** that diagonally connect the vertical sides **131** and the horizontal sides **132**. Here, the pair of vertical sides **131** consists of an inner side **131***a* arranged in an inner side direction of the vehicle and an outer side **131***b* arranged in an outer side direction of the vehicle, the pair of horizontal sides **132** consists of an upper side **132***a* arranged in an upper side direction of the vehicle and a lower side **132***b* arranged in a lower side direction of the vehicle, and each reinforcement rib **14** consists of a horizontal rib **14***a* for connecting the inner side **131***a* and the outer side **131***b* and a vertical rib **14***b* for connecting the upper side **132***a* and the lower side **132***b*.

Both ends of the horizontal rib **14***a* may connect the inner side **131***a* and the outer side **131***b* at an intermediate location between the upper side **132***a* and the lower side **132***b* so as to be able to uniformly improve the rigidity of the upper and lower parts of the vertical side **131** based on the horizontal rib **14***a*.

Further, both ends of the vertical rib **14***b* may connect the upper side **132***a* and the lower side **132***b* at an intermediate location between the inner side **131***a* and the outer side **131***b* so as to be able to uniformly improve the rigidity of the left and right parts of the horizontal side **132** based on the vertical rib **14***b*.

Additionally, the intermediates of the horizontal rib **14***a* and the vertical rib **14***b* are crossed at a right angle, thereby uniformly improving the rigidity of the crash box **10** in the upward/downward and leftward/rightward.

In addition, the horizontal rib **14***a* and the vertical rib **14***b* may be connected entirely along a front/rear length direction of the intermediate connection portion **13** thereby to improve entirely the rigidity of the intermediate connection portion **13** along a front/rear length direction.

Meanwhile, the inner side **131***a* and the upper side **132***a* are connected at an angle of 90 degrees to form a reinforcement portion R and the reinforcement portion R is arranged in an inner side direction of the vehicle.

The reinforcement portion R is a part on which impact energy is concentrated when an RCAR corner test is performed, where it connects the inner side **131***a* and the upper side **132***a* at an angle of 90 degrees thereby to maintain sufficient rigidity thereon.

The crash box **10** according to various embodiments of the present invention may be formed of plastic thereby to be light-weight and improve fuel efficiency.

Further, a guide pin **15** is connected to the rear connection portion **12**, which guides an assembly location when it is assembled with the side member **2**, where the guide pin **15** is inserted into a guide hole formed through the side member **2** to regulate the assembly location of the crash box **10**.

FIGS. **6** and **7** illustrate the crash box **30** according various embodiments of the present invention wherein the crash box **30** may include a front connection portion **31** that is connected to both ends of a back beam **1**, a rear connection portion **32** that is connected to a side member **2** (referring to FIG. **1**), an intermediate connection portion **33** for connecting the front connection portion **31** and the rear connection portion **32**, which is formed as a hollow box shape and through which a cut cross-section of a heptangular shape is formed in a vehicle width direction, and a plurality of pipe tubes **34** formed along a front/rear length direction of the intermediate connection portion **33**.

That is, the intermediate connection portion **33** of the crash box **30** according to various embodiments of the present

invention is formed to have cross section of a heptangular shape and thus it is advantageous for a compress-deformation thereby to implement a high performance satisfaction degree when an RCAR corner test is performed, and further a sufficient rigidity is maintained through the plurality of pipe tubes **34** and thus it is advantageous in responding to an RCAR center test.

The intermediate connection portion **33** is configured to have cross-section of a heptangular shape which is formed by connecting a pair of vertical sides **331** formed in parallel, a pair of horizontal sides **332** formed in parallel, and 3 inclined sides **333** that diagonally connect the vertical sides **331** and the horizontal sides **332**. Here, the pair of vertical sides **331** consists of an inner side **331***a* arranged in an inner side direction of a vehicle and an outer side **331***b* arranged in an outer side direction of a vehicle, the pair of horizontal sides **332** consists of an upper side **332***a* arranged in an upper side direction of a vehicle and a lower side **332***b* arranged in a lower side direction of a vehicle, the inner side **331***a* and the upper side **332***a* are connected at an angle of 90 degrees to form the reinforcement portion R, and the pipe tube **34** is disposed on the reinforcement portion R and the inclined side **333**.

The reinforcement portion R is arranged in an inner side direction of a vehicle, the crash box **30** may be formed of plastic, and a guide pin **35** is connected to the rear connection portion **32**, which guides an assembly location when it is assembled with the side member **2**.

FIGS. **8** to **9** illustrate the crash box **50** according to another embodiment of the present invention in which the crash box **50** may include a front connection portion **51** that is connected to both ends of a back beam **1**, a rear connection portion **52** that is connected to a side member **2** (referring to FIG. **1**), an intermediate connection portion **53** for connecting the front connection portion **51** and the rear connection portion **52**, which is formed as a hollow box shape and through which a cut cross-section of a heptangular shape is formed in a vehicle width direction, a plurality of reinforcement ribs **54** formed at an inner space of the intermediate connection portion **53**; and a plurality of pipe tubes **55** formed along a front/rear length direction of the intermediate connection portion **53**.

That is, the intermediate connection portion **53** of the crash box **50** according to various embodiments of the present invention is formed to have the cross-section of a heptangular shape and thus it is advantageous for a compress-deformation thereby to implement a high performance satisfaction degree when an RCAR corner test is performed, and further a sufficient rigidity is maintained through the plurality of reinforcement ribs **54** and the plurality of pipe tubes **34** and thus it is advantageous in responding to an RCAR center test.

The intermediate connection portion **53** is configured to have the cross-section of a heptangular shape which is formed by connecting a pair of vertical sides **531** formed in parallel, a pair of horizontal sides **532** formed in parallel, and 3 inclined sides **533** that connect slantly the vertical sides **531** and the horizontal sides **532**. Here, the one pair of vertical sides **531** consists of an inner side **531***a* arranged in an inner side direction of a vehicle and an outer side **531***b* arranged in an outer side direction of a vehicle, the one pair of horizontal sides **532** consists of an upper side **532***a* arranged in an upper side direction of a vehicle and a lower side **532***b* arranged in a lower side direction of a vehicle, the inner side **531***a* and the upper side **532***a* are connected at an angle of 90 degrees to form the reinforcement portion R, the reinforcement rib **54** consists of a horizontal rib **54***a* for connecting the inner side **531***a* and the outer side **531***b* and a vertical rib **54***b* for connecting the upper side **532***a* and the lower side **532***b*, and the pipe tube **55** is disposed on the reinforcement portion R and the 3 inclined sides **533**.

Both ends of the horizontal rib **54***a* may connect the inner side **531***a* and the outer side **531***b* at an intermediate location between the upper side **532***a* and the lower side **532***b*, and further, both ends of the vertical rib **54***b* may connect the upper side **532***a* and the lower side **532***b* at an intermediate location between the inner side **531***a* and the outer side **531***b* wherein the horizontal rib **54***a* and the vertical rib **54***b* are connected in a cross shape.

In addition, the horizontal rib **54***a* and the vertical rib **54***b* may be connected entirely along a front/rear length direction of the intermediate connection portion **53**, the reinforcement portion R is arranged in an inner side direction of a vehicle, the crash box **50** may be formed of plastic, and a guide pin **56** is connected to the rear connection portion **52**, which guides an assembly location when it is assembled with the side member **2**.

FIGS. **10** and **11** illustrate the crash box **70** according to various embodiments of the present invention wherein the crash box **70** may include a front connection portion **71** that is connected to both ends of a back beam **1**, a rear connection portion **72** that is connected to a side member **2** (referring to FIG. **1**), a plurality of pipe tubes **75** which connect the front connection portion **71** and the rear connection portion **72** and are arranged on four corners up/downward and left/rightward by a sectional arrangement cut in a vehicle width direction, an intermediate connection portion **73** for connecting the front connection portion **71**, the rear connection portion **72**, and the pipe tube **75**, which is adjacent to the front and rear connection portions and formed as a hollow box shape; and a plurality of reinforcement ribs **74** formed at an inner space of the intermediate connection portion **73**.

Further, the crash box **70** may further include a reinforcement pipe **77** that is arranged to be inserted into the pipe tube **75**.

The reinforcement pipe **77** greatly increases the rigidity of the whole crash box **70** through strength reinforcement of the pipe tube **75** in which one reinforcement pipe **77** is press-inserted into each pipe tube **75** and is formed of plastic so as to be light-weight.

The intermediate connection portion **73** of the crash box **70** according to various embodiments of the present invention is configured to connect the pipe tubes **75** that are installed by a quadrangular arrangement and thus it is advantageous for a compress-deformation thereby to implement a high performance satisfaction degree when an RCAR corner test is performed, and further, a sufficient rigidity is maintained through the plurality of reinforcement ribs **74** and the plurality of pipe tubes **75** and thus it is advantageous in responding to an RCAR center test.

The intermediate connection portion **73** consists of, as shown in FIG. **11**, a pair of vertical sides **731** formed in parallel and a pair of horizontal sides **732** formed in parallel wherein the one pair of vertical sides **731** consists of an inner side **731***a* that is arranged in an inner side direction of a vehicle and connects the upper and lower pipe tubes **75** at an inner side and an outer side **731***b* that is arranged in an outer side direction of a vehicle and connects the upper and lower pipe tubes **75** at an outer side, the one pair of horizontal sides **732** consists of an upper side **732***a* that is arranged in an upper side direction of a vehicle and connects the upper pipe tubes **75** that are arranged at inner and outer sides and a lower side **732***b* that is arranged in a lower side direction of a vehicle and connects the lower pipe tubes **75** that are arranged at inner and outer sides, and the reinforcement rib **74** consists of a hori-

zontal rib **74***a* for connecting the inner side **731***a* and the outer side **731***b* and a vertical rib **74***b* for connecting the upper side **732***a* and the lower side **732***b*.

Both ends of the horizontal rib **74***a* may connect the inner side **731***a* and the outer side **731***b* at an intermediate location between the upper side **732***a* and the lower side **732***b*, and further, both ends of the vertical rib **74***b* may connect the upper side **732***a* and the lower side **732***b* at an intermediate location between the inner side **731***a* and the outer side **731***b* wherein the horizontal rib **74***a* and the vertical rib **74***b* are connected in a cross shape.

The horizontal rib **74***a* and the vertical rib **74***b* are connected entirely along a front/rear length direction of the intermediate connection portion **73**, the crash box **70** may be formed of plastic, and a guide pin **76** is connected to the rear connection portion **72**, which guides an assembly location when it is assembled with the side member **2**.

As described above, according to the crash box of the present invention, the intermediate connection portion is configured to have cross-section of a heptagonal shape so as to maintain impact absorption and rigidity and thus it is advantageous for a compress-deformation, thereby implementing a high performance satisfaction degree when an RCAR corner test is performed. Further a sufficient rigidity is maintained through the plurality of reinforcement ribs and the plurality of pipe tubes and thus it is advantageous in responding to an RCAR center test.

In addition, the crash box according to various embodiments of the present invention may be formed of plastic thereby to be light-weight and improve fuel efficiency.

For convenience in explanation and accurate definition in the appended claims, the terms "upper", "lower", "inner" and "outer" are used to describe features of the exemplary embodiments with reference to the positions of such features as displayed in the figures.

The foregoing descriptions of specific exemplary embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to thereby enable others skilled in the art to make and utilize various exemplary embodiments of the present invention, as well as various alternatives and modifications thereof. It is intended that the scope of the invention be defined by the Claims appended hereto and their equivalents.

What is claimed is:

1. A crash box for a vehicle comprising:

a front connection portion connected to both ends of a back beam of the vehicle;

a rear connection portion that is connected to a side member of the vehicle;

an intermediate connection portion for connecting the front connection portion and the rear connection portion, formed as a hollow box shape and through which a cross-section of a heptangular shape is formed in a vehicle width direction;

a plurality of reinforcement ribs formed at an inner space of the intermediate connection portion; and

a plurality of pipe tubes formed along a front/rear length direction of the intermediate connection portion.

2. The crash box for the vehicle of claim **1**,

wherein the intermediate connection portion is configured to have the cross-section of the heptangular shape which is formed by connecting a pair of vertical sides formed in parallel, a pair of horizontal sides formed in parallel, and three inclined sides that connect slantly the vertical sides and the horizontal sides,

wherein the pair of vertical sides includes an inner side arranged in an inner side direction of the vehicle and an outer side arranged in an outer side direction of the vehicle,

wherein the pair of horizontal sides includes an upper side arranged in an upper side direction of the vehicle and a lower side arranged in a lower side direction of the vehicle,

wherein the inner side and the upper side are connected at an angle of 90 degrees to form a reinforcement portion,

wherein the reinforcement rib includes a horizontal rib for connecting the inner side and the outer side and a vertical rib for connecting the upper side and the lower side, and

wherein each pipe tube is disposed on the reinforcement portion and each of the three inclined sides.

3. The crash box for the vehicle of claim **2**, wherein both ends of the horizontal rib connect the inner side and the outer side at an intermediate location between the upper side and the lower side, both ends of the vertical rib connect the upper side and the lower side at an intermediate location between the inner side and the outer side, and the horizontal rib and the vertical rib are connected in a cross shape.

4. The crash box for the vehicle of claim **2**, wherein the horizontal rib and the vertical rib are connected entirely along a front/rear length direction of the intermediate connection portion.

5. The crash box for a vehicle of claim **2**, wherein the reinforcement portion is arranged in an inner side direction of the vehicle.

6. The crash box for a vehicle of claim **1**, wherein the crash box is formed of plastic.

7. The crash box for the vehicle of claim **1**, wherein a guide pin is connected to the rear connection portion, which guides an assembly location when assembled with the side member.

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